PCT/GB2004/003607

The Patent Office

PATENTS • DESIGNS • COPYRIGHT • TRADE MARKS

INVESTOR IN PEOPLE

The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

REC'D 10 SEP 2004
WIPO

PRIORITY DOCUMENT

SUBMITTED OR TRANSMITTED IN COMPLIANCE WITH RULE 17.1(a) OR (b)

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

Signed

Dated 2 September 2004

Patents Form 1/77

Patents Act 1977
(Rule 16)

The Patent Office

THE PATENT OFFICE
M
06 SEP 2003
NEWPORT

08SEP03 E835540-1 C26047
P01/7700 0.00-0320925.1

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office

Cardiff Road
Newport
South Wales
NP10 8QQ

1. Your reference	0300270
2. Patent application number *(The Patent Office will fill in this part)*	0320925.1 06 SEP 2003
3. Full name, address and postcode of the or of each applicant *(underline all surnames)*	SMITHS GROUP PLC 765 FINCHLEY ROAD LONDON NW11 8DS
Patents ADP number *(if you know it)*	8032310001
If the applicant is a corporate body, give the country/state of its incorporation	GB
4. Title of the invention	SPECTROMETER APPARATUS
5. Name of your agent *(if you have one)*	J. M. FLINT
"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*	765 FINCHLEY ROAD LONDON NW11 8DS
Patents ADP number *(if you know it)*	1063304001

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*
a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
See note (d))

YES

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	
Description	5
Claim(s)	1
Abstract	
Drawing(s)	2 + 2

10. If you are also filing any of the following, state how many against each item.

Priority documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	

11. I/We request the grant of a patent on the basis of this application.

Signature J-Q̶ Date 03/09/03

12. Name and daytime telephone number of person to contact in the United Kingdom J. M. FLINT 020 8457 8220

Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

Notes

a) *If you need help to fill in this form or you have any questions, please contact the Patent Office on 08459 500505.*

b) *Write your answers in capital letters using black ink or you may type them.*

c) *If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.*

d) *If you have answered 'Yes' Patents Form 7/77 will need to be filed.*

e) *Once you have filled in the form you must remember to sign and date it.*

f) *For details of the fee and ways to pay please contact the Patent Office.*

SPECTROMETER APPARATUS

This invention relates to spectrometer apparatus.

Spectrometers, in particular, infrared spectrometers are used extensively to analyse a wide variety of substances. Where the substance is highly absorbing an ATR (attenuated total reflectance) unit may be used such as the Golden Gate ATR sold by Specac Limited of Orpington, Kent, England (Golden Gate is a Registered Trade Mark of Specac Limited). This ATR unit has a diamond prism window on which the sample is placed. An arm extends over the window and carries a screw-mounted anvil that applies a high compressive force to the sample to force it into close contact with the upper surface of the window. An optical system below the window directs a small spot of infrared radiation onto the window at an angle of about 45°. Infrared radiation is reflected at the interface of the window surface and the sample and is absorbed within a short penetration depth in the sample. Radiation reflected from the sample is collected and passed to the spectrometer detector for analysis.

Whilst such ATR units can function satisfactorily for the measurement of a single spatial point, it is desirable to increase resolution and signal-to-noise ratio.

It is an object of the present invention to provide alternative spectrometer apparatus.

According to one aspect of the present invention there is provided spectrometer apparatus including a radiation transparent window for supporting a sample on one surface, means for urging the sample into close contact with the window surface, means for directing

radiation onto the sample through the opposite side of the window at an angle to the normal to the window surface, means for receiving radiation reflected from the sample through the window, and a corrective optics device arranged to increase the accuracy of imaging of the surface of the sample.

The apparatus preferably includes two corrective optics devices. The or each corrective optics device preferably includes a wedge-shape prism.

Spectrometer apparatus in the form of an ATR unit for a spectrometer system will now be described, by way of example, with reference to the accompanying drawing, in which:

Figure 1	is a partly sectional side elevation view of the apparatus;
Figure 2	is a perspective view of one of the wedge-shape prisms; and
Figure 3	is a side elevation view of the diamond window.

The ATR unit 1 forms a part of a spectrometer system including an infrared source 2, an analyser 3 and a detector 4. The detector 4 is preferably a scanned focal plane array, such as a 64x64 pixel Javelin detector made by Raytheon of Santa Barbara, USA, each pixel measuring 60x60μm. This detector 4 enables an image to be produced across the area of the sample being tested.

The unit 1 has a housing 10 of substantially square section with an upper plate 11 supporting a small central sample window 12 (Figure 3) in the form of a right angle diamond prism, which is mechanically robust and infrared transparent. The prism 12 has its hypotenuse face 12H uppermost, this being the face on which the sample is placed. A clamping arm 13 is pivoted at its left-hand end 14 and has a lock 15 at its right hand end by which it can be secured with the upper plate 11. The arm 13 extends across the window 12 and has a screw-threaded rod 16 projecting down midway along its length, with a tapered anvil 17 at its lower end and a knurled knob 18 at its upper end above the arm. Once the arm 13 is locked in position, the knob 18 can be twisted to lower or raise the anvil 17.

The optical system 19 of the unit is contained within the housing 10 beneath the upper plate 11. On the left-hand wall 20 of the housing there is an entrance window 21 aligned with the source 2. The entrance window 21 is aligned along a horizontal axis with a plane mirror 22 mounted centrally of the unit and inclined at about 15° to the vertical such that radiation falling on the mirror from the window is reflected upwardly at an angle of about 30° to the horizontal and towards the left. A second plane mirror 23 is mounted on the left-hand wall 20 and is angled upwardly such that radiation incident on it is reflected upwardly towards the right at an angle of about 45° to the horizontal. An imaging lens assembly 24 is positioned directly adjacent the mirror 23, between the mirror and the sample window 12. The positioning and power of the imaging lens assembly 24 is such that an image of the infra-red source 2 is focussed through a side face 12L of the window prism 12 onto the upper, hypotenuse surface 12H. A second, collecting lens assembly 25 is positioned below and to the right of the sample window 12 and is oriented at right angles to the imaging lens assembly 24 in line with the beam of radiation reflected from the sample on the window. A

third plane mirror 26 mounted on the right-hand wall 27 of the housing 10 is angled so that the beam of radiation incident on it is reflected downwardly to the left at an angle of about 30° to the horizontal. A fourth plane mirror 28 is mounted adjacent the first mirror 22 and is inclined in the opposite sense so that the beam of radiation incident on it is reflected to the right along a horizontal axis to an exit window 29 in the right-hand wall 27 of the housing 10.

It will be appreciated that the transparent elements 21, 24 and 29 of the optical system 19 are made of materials transparent to infrared radiation, such as ZnSe.

As so far described, the optical system 19 is substantially conventional. With such an arrangement, the focal plane would typically not be coplanar with the sample face 12H but could be inclined at an angle of about 50°, as shown by the broken line FP in Figure 3. The system, however, includes corrective optics provided by two further elements in the form of wedge-shape prisms 40 and 41 located respectively in the incident ray path and in the path of rays reflected from the sample. The first prism 40 is located between the two mirrors 22 and 23 and is oriented with the narrow apex 42 of the prism extending parallel to the z axis, that is, normal to the plane of the paper, with the two larger, angled faces 43 and 44 of the prism extending generally transversely of the ray paths between the two mirrors, and with the narrow apex lower than the wider edge 45. The other prism 41 is located between the other two mirrors 26 and 28 and again this is oriented with its narrow apex 46 extending parallel to the z axis, with the two larger, angled faces 47 and 48 extending generally transversely of the ray paths between the two mirrors, and with the narrow apex 42 lower than the wider edge 45.

Without the two wedge prisms 40 and 41, the sample surface would not be formed correctly over its whole area and would suffer anamorphic distortion. For example, a circular sample would appear to be elliptical. This may not be important where the apparatus is used only to make macroscopic measurements of the sample but they become particularly important where the sample is imaged and spectrometeric analysis is made at different points across the image, as is now possible using elemental area array detectors.

The wedge prisms provide relatively simple corrective optics that can be incorporated into the existing system with minimal losses. The wedge prisms can correct the focal plane orientation so that it is co-planar with the sampling face of the diamond window and thereby correct the anamorphism. The prisms can also help correct for chromatic aberration for the infrared radiation wavelengths typically used across the entire face of the sampling window. The prisms also enable a minimisation of the resolvable area when using elemental area, array detectors and can increase the signal-to-noise ratio.

Although the best results are achieved with two wedge prisms, one in the incident ray path and one in the reflected ray path, it is not essential to use two prisms since some improvement is obtained with a wedge prism in only the reflected ray path.

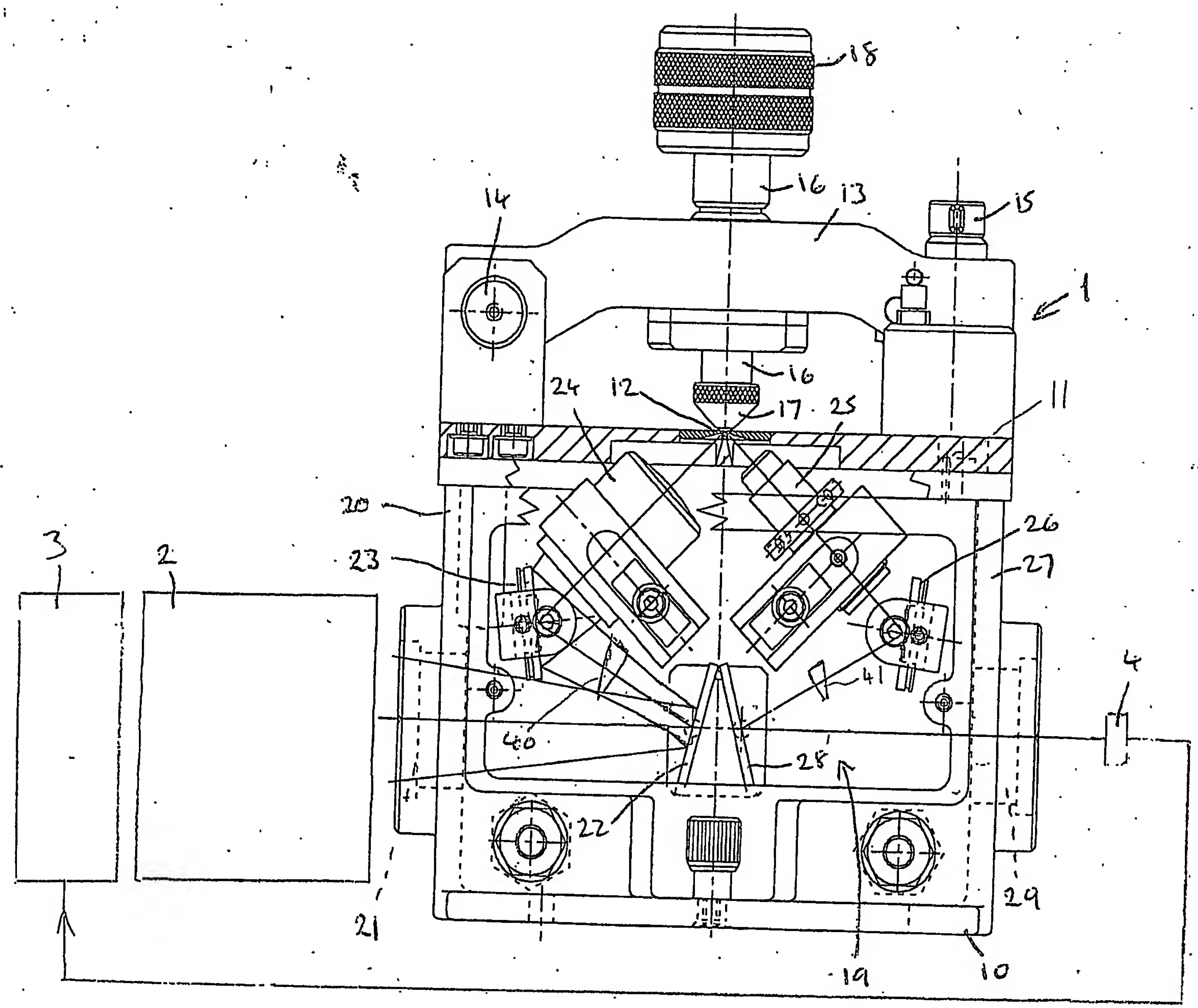
1
2
3
4
10
11
12
13
14
15
16
16
17
18
19
20
21
22
23
24
25
26
27
28
29
40
41

FIG. 1

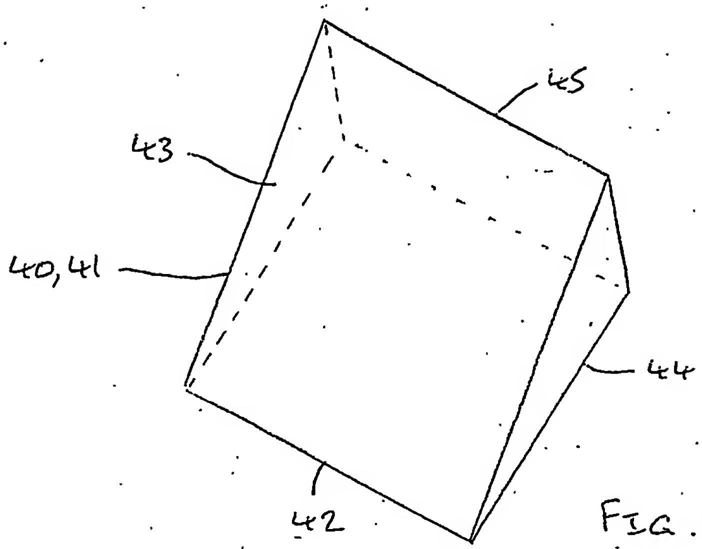

FIG. 2

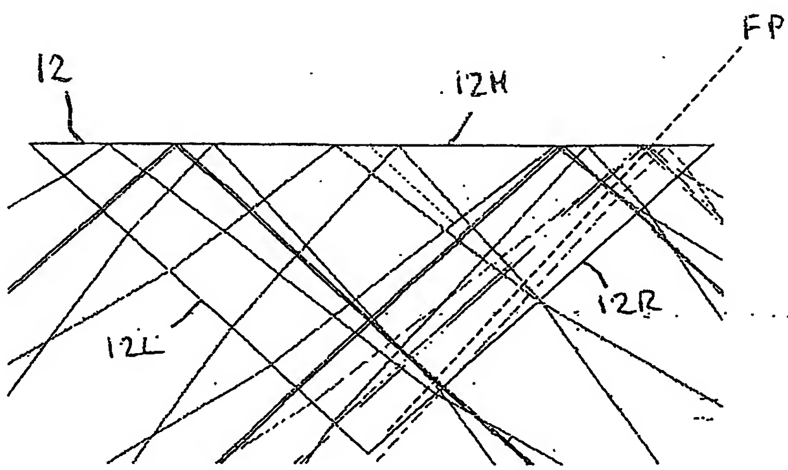

FIG. 3